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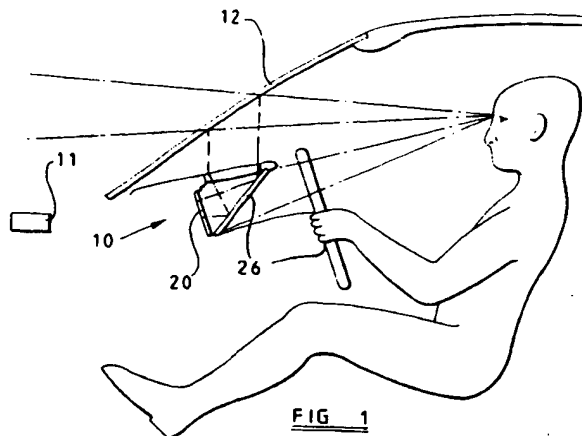
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(54) Head up displays for motor vehicles.

(57) A head up display system (10) for a motor vehicle includes a sensor (11), display means (20) for forming a video image from the signals received from the sensor (11) and a projection system (22, 24, 25, 26) for projecting the video image onto the windscreen (12) of the vehicle, the projection system (22, 24, 25, 26) including a mirror (26) for deflecting the optical path of the projected image, said mirrors (26) being located directly in front of a driver of the vehicle at a level outside the normal field of view of the driver through the windscreen (12), the mirror (26) being arranged ; in a head up display mode, to direct the projected image onto the windscreen (12) ; and in a non-head up display mode, to permit direct viewing of the video image at a level outside the normal field of view of the driver through the windscreen (12).



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The present invention relates to head up displays for motor vehicles.

It has been proposed to provide a head up display for a motor vehicle in which an enhanced view of the road ahead is projected onto the vehicle windscreen, so that it is overlaid onto the drivers view of the scene. In this manner, potential hazards which may not be clearly visible to the driver, may be highlighted.

In order to ensure that the objects within the image appear to the driver to be the same size as the objects in the real scene, the field of view of the sensor is matched to the field of view which the driver has of the display. The image is then projected into the relevant area of the driver's forward line of sight and is arranged such that the driver's own view of the objects is overlaid with the images of the objects generated from the sensor, processing and display combinations.

To produce an overlaid image of this type, a large field of view is required. Within the constraints of the motor vehicle which places limitations on the size of the video display device which may be used and the optical path length of the projected image, this may be achieved by the use of a mirror which will bend the optical path. This will also allow the display device to be positioned behind the dashboard of a vehicle, the mirror serving to deflect the projected image onto the windscreen.

The centre line of the projected image and the centre line of the driver's forward field of view must also be coincident. As a result, the mirror used to deflect the projected image onto the windscreen must be positioned directly in front of the driver at a level below the level of the windscreen. That is, in a position conventionally used for the vehicle instrument display. The positioning of a mirror in this way will consequently significantly reduce the area available for vehicle instrument display.

According to one aspect of the present invention a head up display system for a motor vehicle comprises sensor means, means for forming a video image from the signals received from the sensor means and means for projecting the video image onto the windscreen of the vehicle, characterised in that said means for projecting the video image includes a mirror for deflecting the optical path of the projected image, said mirror being located directly in front of a driver of the vehicle at a level outside the normal field of view of the driver through the windscreen; the mirror being adapted, in a head up display mode, to permit projection of the image onto the windscreen; and, in a non-head up display mode, to permit viewing of the projected image at a level outside the normal field of view of the driver through the windscreen.

In accordance with the above described invention, when in the head up display mode the system will project the projected image onto the windscreen. However, in a non-head up display mode, the means

for forming a video image may be used to provide a flexible format display which may form part of the conventional instrument display of the vehicle. This flexible format display may be used, for example, to display operating parameters of the vehicle, navigational information and/or views to the rear or sides of the vehicle for manoeuvring purposes.

Preferably the mirror reflects the projected image onto the windscreen in the head up display mode and permits passage of the projected image so that it may be viewed directly in the non-head up display mode. The mirror is furthermore preferably located at a level below that of the windscreen.

According to one embodiment of the invention, the mirror is a narrow band reflector, so that only light in a narrow waveband is reflected onto the windscreen. This form of mirror may be used with a light source emitting light within the narrow band, when in the head up display mode and a second light source emitting light outside the narrow band when in the non-head up display mode. However, preferably wide band light source is used in both modes, shutter means being provided to intercept the reflected light when in the non-head up display mode.

Alternatively, the mirror may be switchable electronically, by for example the use of electrochromic coatings or solutions; or may be movable mechanically between a position in which it is disposed in the path of the projected image and reflects the image onto the windscreen; and a position in which it is clear of the path of the projected image. Such systems may be used to project full colour or limited waveband images onto the windscreen.

An embodiment of the invention is now described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a partial sectional elevation of a motor vehicle with head-up display in accordance with the present invention;

Figure 2 is a plan view of an instrument panel of a vehicle fitted with a head-up display in accordance with the present invention; and

Figure 3 is a sectional elevation of the head-up display system used in the vehicle illustrated in Figure 1.

As illustrated in Figure 1, the head up display system 10 of the present invention projects an image onto the windscreen 12 of the vehicle, which coincides with the driver's view of the scene ahead of the vehicle. The head up display is arranged such that images produced by the head up display system are overlaid onto the objects viewed directly by the driver.

As illustrated in greater detail in Figures 2 and 3, the head up display system 10 includes a mirror 26 which reflects a projected image onto the windscreen 12. The mirror 26 is adapted to permit the passage of a projected image when the head up display system is not on, to provide a flexible format display which

may be viewed in a head down display mode.

As illustrated in Figures 2 and 3, the head up display system 10 comprises a liquid crystal display 20 which converts signals from a sensor 11 which looks forwardly of the vehicle, into a video image. The sensor may operate in the infra-red, visible and/or ultra-violet wavelengths and the signals therefrom are processed to enhance the image.

The liquid crystal display 20 is illuminated by a wide band light source 22 and a lens system 24, 25 projects the video image produced by the liquid crystal display 20 onto a narrow waveband mirror 26, which is located centrally of the vehicle instrument panel 30 as illustrated in Figure 2. The mirror 26 reflects light within the narrow waveband upwardly through an exit lens 28 and onto the windscreen 12. Light of wavelength outside the narrow waveband of mirror 26 is transmitted through the mirror 26 to provide a flexible format display which may be viewed on the reverse side of the mirror 26.

In the head up display mode of operation, the video image produced by the liquid crystal display 20 is reflected onto the windscreen 12 by mirror 26, so that it may be viewed by the driver. A display of reduced colour range of the image is also transmitted through the mirror 26 and may be viewed by the driver in a head down display mode.

When the head up display is switched off, a shutter 27 is placed over the exit lens 28, so that no image is projected onto the windscreen 12. The shutter 27 also prevents reflections from the optical system of the head up display system which would otherwise be reflected onto the windscreen 12. The shutter 27 may, for example, be a layer or solution of electrochromic material controlled electronically, or may be a mechanically controlled shutter.

When the shutter 27 is closed, the liquid crystal display 20 may be used in a flexible format display mode, to provide a reduced colour range display on the reverse side of the mirror 26 which may be viewed in a head down display mode. This flexible format display may be used to display vehicle parameters and symbols, navigational information or other similar data.

In the embodiment illustrated above, only the central part of the mirror 26 need be used for head up display purposes. The top and bottom regions 32 and 34 may for example be arranged to transmit light over the full visible spectrum and the corresponding regions 35, 36 of the liquid crystal display 20 may give a permanent display of vehicle parameters or symbols which will be displayed in the full colour range, on the reverse side of the mirror 26, whether the head up display is functional or not. Such information may be in the form of an array of warning lights corresponding to various parameters of the vehicle.

The liquid crystal display 20 may furthermore be used to superimpose warning messages on the wind-

screen when in the head up display mode. Such messages should not however unduly distract the drivers attention from the road. This mode of operation of the system may be used, for example, to give warning of failure of vital systems of the vehicle, collision avoidance information or indications for turning the vehicle generated by navigational systems.

Various modifications may be made without departing from the invention. For example, while in the above embodiment the video image is produced by a liquid crystal display, other display devices which will create an image which may be projected for example, cathode ray tubes, ferromagnetic displays or plasma displays, may be used. Furthermore, in place of a narrow waveband mirror, an electronically controlled electrochromic mirror or mechanically moved mirror may be used.

## Claims

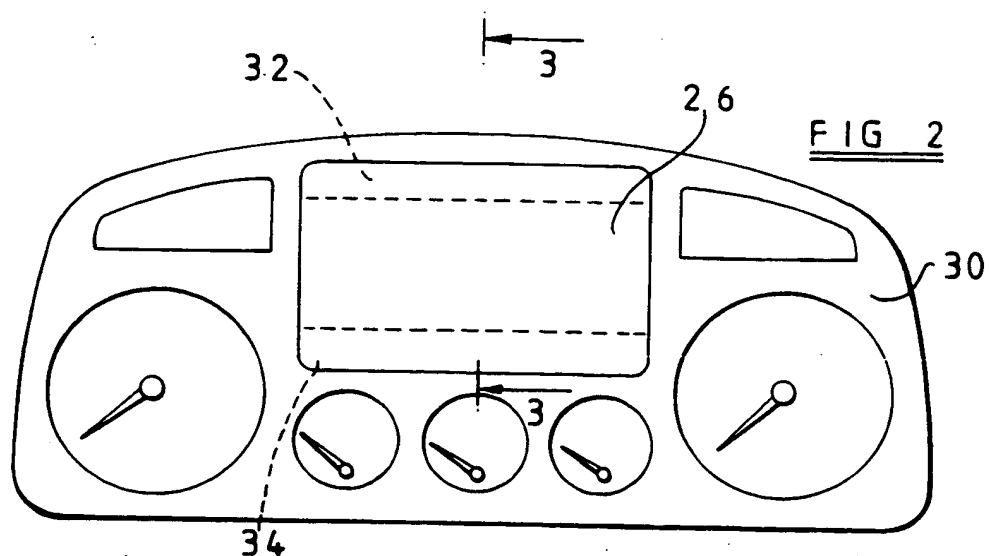
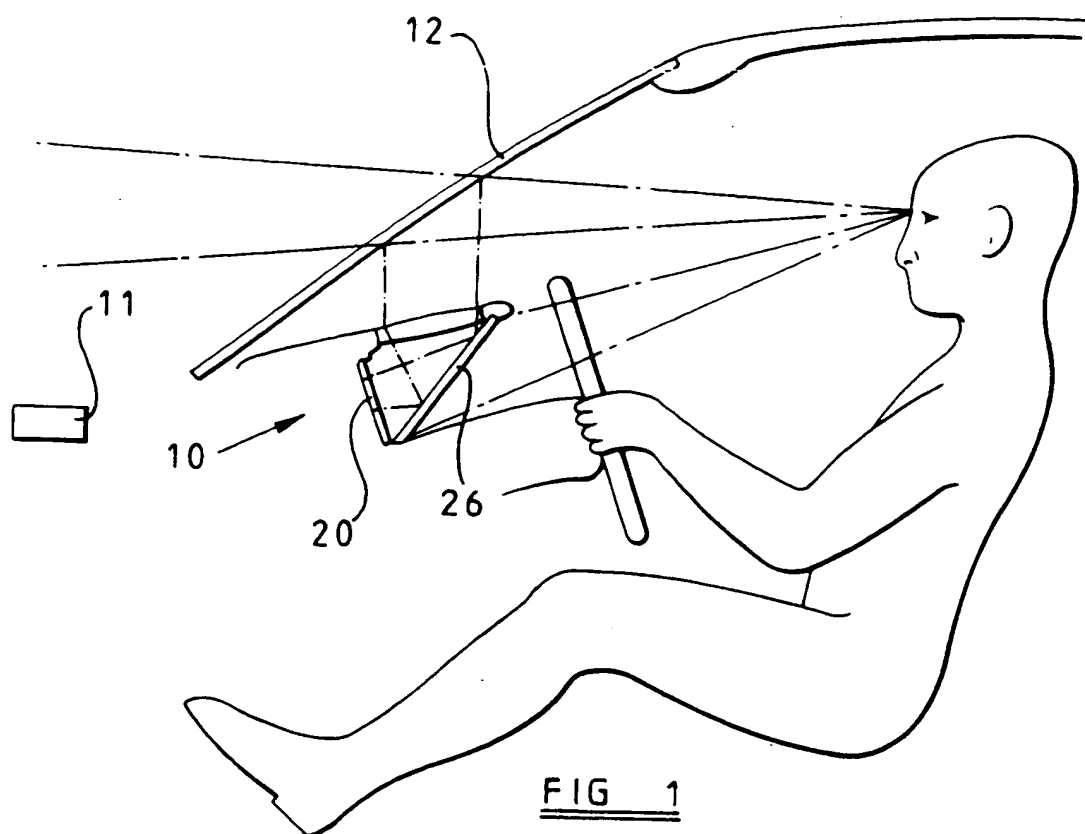
1. A head up display system (10) for a motor vehicle comprising sensor means (11), means (20) for forming a video image from the signals received from the sensor means (11) and means (22, 24, 25, 26) for projecting the video image onto the windscreen (12) of the vehicle, characterised in that said means (22, 24, 25, 26) for projecting the video image includes a mirror (26) for deflecting the optical path of the projected image, said mirror (26) being located directly in front of a driver of the vehicle at a level outside the normal field of view of the driver through the windscreen (12); the mirror (26) being adapted, in a head up display mode, to permit projection of the image onto the windscreen (12); and, in a non-head up display mode, to permit viewing of the image at a level outside the normal field of view of the driver through the windscreen (12).
2. A head up display system (10) according to Claim 1 characterised in that the image projected onto the windscreen (12) is a view of the scene ahead of the vehicle, the image being projected onto the windscreen (12) so that the image overlays the actual scene as viewed by the driver of the vehicle.
3. A head up display system (10) according to Claim 1 or 2 characterised in that the mirror (26) reflects the projected image onto the windscreen (12) in the head up display mode and permits passage of the projected image so that it may be viewed directly in the non-head up display mode.
4. A head up display system (10) according to any one of Claims 1 to 3 characterised in that the mirror (26) is located at a level below the level of the

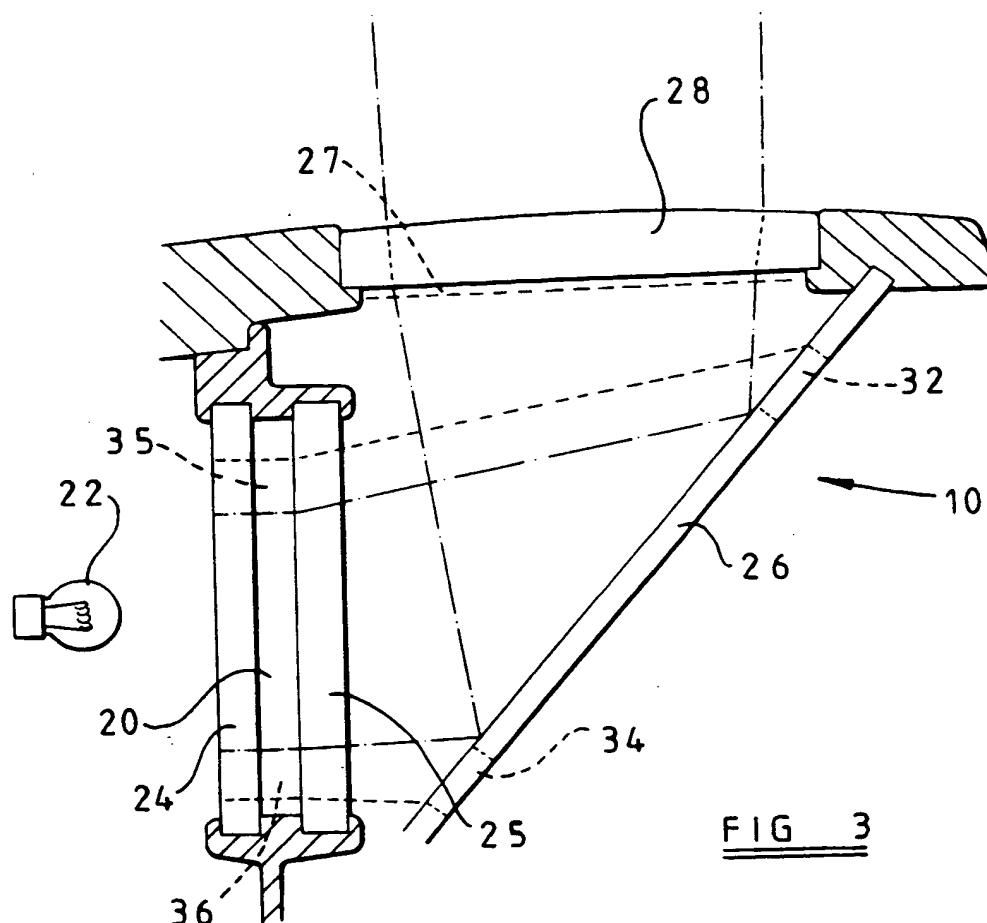
windscreen (12).

5. A head up display system (10) according to any one of Claims 1 to 4 characterised in that the mirror (26) is a narrow band reflector. 5
6. A head up display system (10) according to Claim 5 characterised in that the means (22, 24, 25, 26) for projecting the video image includes a wide band light source (22), light of wavelengths corresponding to the narrow band of the reflector being reflected onto the windscreen (12) while light of wavelengths outside that of the narrow band reflector being transmitted through the mirror (26). 10
7. A head up display system (10) according to Claim 6 characterised in that shutter means (27) is provided, to be located between the mirror (12) and windscreen to intercept the projected image, when the head up display (10) is switched off. 15
8. A head up display system (10) according to Claim 7 characterised in that the shutter (27) is provided by an electronically controlled electrochromic layer or solution. 20
9. A head up display system (10) according to Claim 7 characterised in that a mechanical shutter (27) is moved into the path of the projected image when the head up display system is switched off. 25
10. A head up display system (10) according to Claim 5 characterised in that, in the head up display system mode, the projected image is produced by a narrow band light source (22) corresponding to the narrow band reflector. 30
11. A head up display system (10) according to any one of Claims 1 to 4 characterised in that the mirror (26) is electronically switchable between a reflective mode and a transmissive mode. 35
12. A head up display system (10) according to Claim 11 characterised in that the mirror (26) comprises an electrochromic coating or solution. 40
13. A head up display system (10) according to any one of Claims 1 to 4 characterised in that the mirror (26) is movable mechanically between a position in which it is disposed in the path of the projected image and reflects the image onto the windscreen (12), and a position in which it is clear of the path of the projected image. 45
14. A head up display system (10) according to any one of the preceding claims characterised in that the means (20) for forming a video image may be 50

used to produce a flexible format display, to be viewed at a level outside the normal field of view of the driver through the windscreen (12), when the head up display system is switched off.

15. A head up display system (10) according to any one of the preceding claims characterised in that the device (20) for forming a video image is a liquid crystal display, cathode ray tube, ferromagnetic display or plasma display. 55
16. A head up display system (10) according to any one of the preceding claims characterised in that the mirror (26) is arranged to permit passage of a portion of the projected image whether the head up display system is functional or not, the means (20) for forming the video image being used to produce a permanent flexible format display corresponding to said portion of the projected image. 60
17. A head up display system (10) according to Claim 14 or 16 characterised in that the flexible format display (20) provides a display of vehicle parameters and symbols, navigational information and/or views to the rear or sides of the vehicle for manoeuvring purposes. 65
18. A head up display system (10) according to any one of the preceding claims characterised in that the means (20) for forming a video image is arranged to superimpose warning messages on the windscreen (12), when the system is in the head up display mode. 70







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# EUROPEAN SEARCH REPORT

Application Number  
EP 94 30 5621

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION
X	WO-A-87 06017 (HUGUES AIRCRAFT)  * abstract; figure 2A * * page 5, line 2 - line 5 * * page 10, line 21 - line 24 * * page 11, line 15 - line 18 * ---	1,3-6, 10,15-18	G02B27/01 B60K37/00 G02B27/00
X	US-A-3 885 095 (WOLFSON)  * column 2, line 56 - line 60; figure 2 * * column 3, line 21 - line 67 * * column 3, line 54 - line 62; figure 5 * ---	1,3,4, 14-18 7,9	
A			
X	GB-A-1 409 743 (SECRETARY OF STATE FOR DEFENSE)  * the whole document * ---	1,3,4, 13-15, 17,18 5	
A			
A	EP-A-0 326 323 (KAISER)  * abstract; figure 3A * * column 1, line 25 - line 32; figure 1A * * column 3, line 36 - line 39; figures 4A,4B * * column 6, line 31 - line 35 * ---	1,3-6, 10,11, 14-16	TECHNICAL FIELDS SEARCHED (Int. CL. 6)  G02B
A	DE-U-92 01 038 (LEUBE) * claims 1,7 * ---	2,15	
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 176 (P-214) (1321) 4 August 1983 & JP-A-58 080 616 (MITSUBISHI) 14 May 1983 * abstract * --- -/-	8,11,12	
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>13 January 1995</b>	Examiner <b>Soulaire, D</b>
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document  T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons  & : member of the same patent family, corresponding document			

EPO FORM 1500 (12/92) (P04C01)



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Application Number  
EP 94 30 5621

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION
A	CHIP, no.6, June 1990, WURZBURG, GERMANY pages 20 - 24, XP125797 RAINER GRABOWSKI 'Head-up display, Bilder und texte schweben wie eine Fata Morgana im Raum erzeugt von Head-up Displays, die jetzt Einzug in die Alltagswelt halten. Es liegt was in der luft' * page 23, paragraph 2 -paragraph 3 * * page 24, column 3, paragraph 2 * ---	15,17,18	
A	EP-A-0 420 196 (CANON) * column 6, line 43 - line 46; figures 2,5 * ---	15	
A	US-A-5 037 182 (GROVES) * abstract * ---	17	
A	US-A-4 737 001 (MOSS) * abstract * ---	17	
A	DE-A-28 47 590 (HOLTZ) * claim 1 * -----	15	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. CL.6)
Place of search THE HAGUE		Date of completion of the search 13 January 1995	Examiner Soulaire, D
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- a : member of the same patent family, corresponding document</p>			

EPO FORM 1503 02.82 (P04/C01)